1-1 DEAD LOADS USED TO DETERMINE BRIDGE RATINGS

The dead load unit weights given in the current AASHTO Standard Specifications for Highway Bridges shall be used except where superseded by the CDOT Staff Bridge Design Manual. Some examples are asphalt and bridge rail.

Use 5 psf for the unit weight of formwork when it is likely the formwork will remain in place. Some examples are closed cell construction, such as cast-in-place concrete box girders and steel box girders.

Rating for new bridges shall be performed using an asphalt thickness of 3". When existing bridges are rerated, either an asphalt thickness of 3" or the existing asphalt thickness if it is greater than 3" shall be used. Unless field changes due to collision or deterioration of bridge members are severe and posting loads, color code and sufficiency rating are not impacted, rerating existing bridges for field changes shall not be performed when the change in asphalt thickness is less than 3".

1-2 LIVE LOADS USED TO DETERMINE BRIDGE RATINGS

The live loads to be used for rating shall be as specified in the current AASHTO Standard Specifications for Highway Bridges and the AASHTO Manual For Bridge Evaluation.

The HS20-44 truck and lane load shall be used when computing the Inventory and Operating rating for all structures. See Figure 1-1.

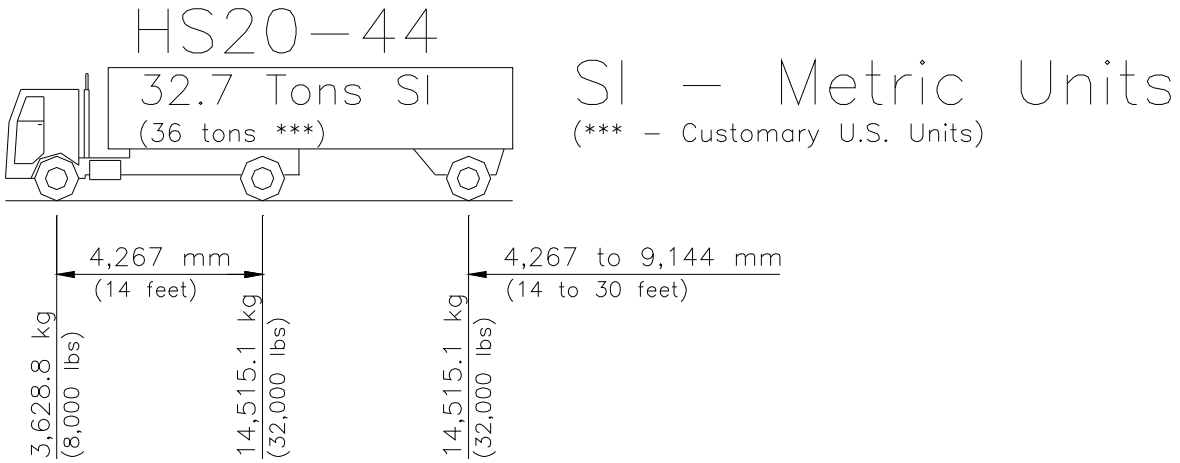
The Posting rating shall be computed using the Posting Vehicles shown in Figures 1-2, or 1-3. For mainline Interstate routes, or Interstate access ramps, the Posting Vehicles shown in Figure 1-3, shall be used. For all other routes, including Interstate business routes, the Posting Vehicles shown in Figure 1-2, shall be used.

Posting Vehicles are composed of the maximum vehicle loads allowed by Colorado law. The difference between the live loads in Figures 1-2, and 1-3, is due to the maximum legal loads allowed on Interstate highways being different from those allowed on other Colorado roadways.

The Overload Color Code rating shall be computed using the live loads defined in Subsection 1-16.

Rating Truck

Vehicle used to determine the Inventory and Operating Ratings for all bridges within Colorado



Lane Placement

Typical lane placement for all rating trucks used by Colorado.

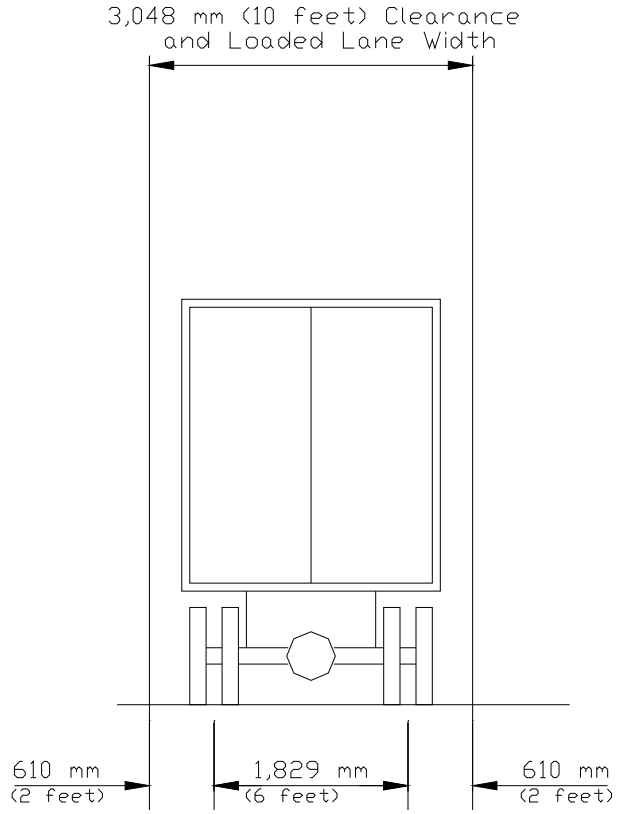


Figure 1-1

Colorado Posting Trucks

Vehicles used to determine Posting Ratings of bridges subject to Colorado Loadings.

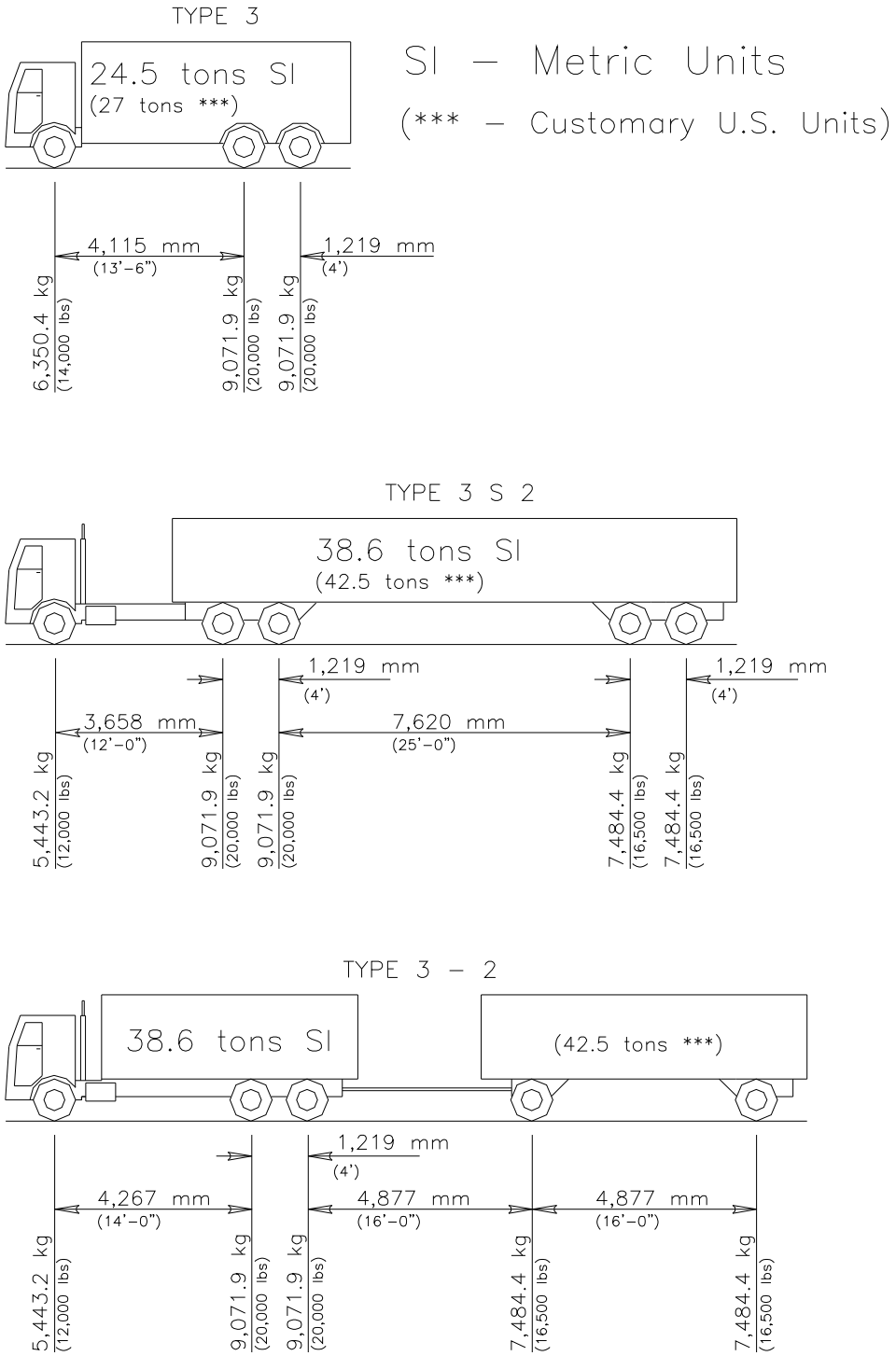


Figure 1–2

Interstate Posting Trucks

Vehicles used to determine Posting Ratings of bridges subject to Interstate Loadings.

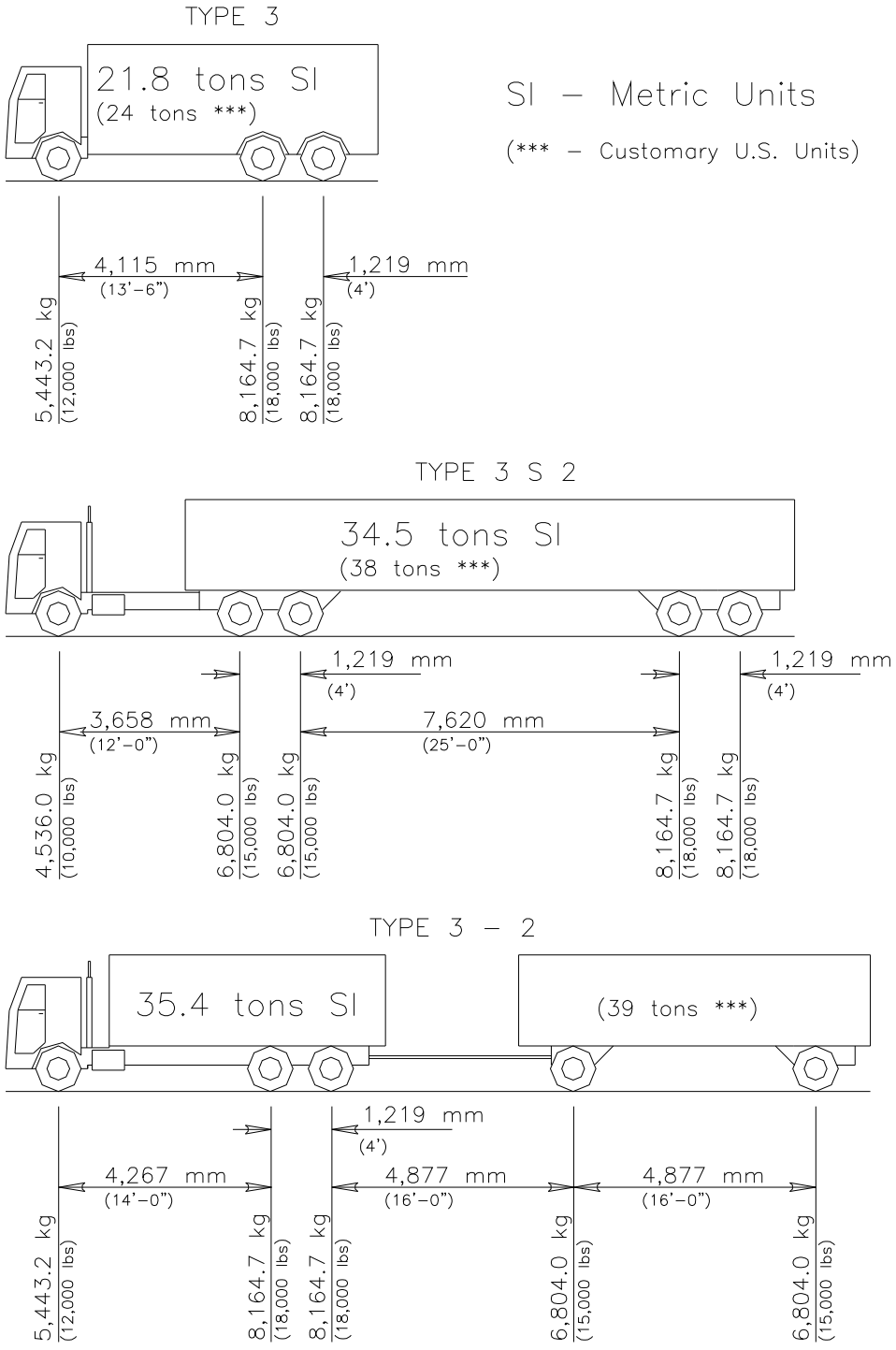


Figure 1-3

1-3 IMPACT AND DISTRIBUTION OF LIVE LOADS

The live load impact used for rating shall be as specified in the current AASHTO Standard Specifications for Highway Bridges except as noted. Full impact shall be used for all ratings: HS20 inventory, HS20 operating, posting, and overload color code ratings.

A) For overload permit analysis (i.e., gross vehicle weight over 200,000 lbs) when reduced vehicle speed is enforced, impact may be reduced when crossing the structure.

The live load distribution factors used for rating shall be as specified in the current AASHTO Standard Specifications for Highway Bridges and AASHTO Manual for Bridge Evaluation except as noted and elsewhere in the manual.

A) Live load distribution factors for concrete box girders shall be calculated according to the current CDOT Bridge Design Manual.

B) When rating bridges constructed after 1985, use the multi-lane live load distribution factor to determine the overload color code. See Section 1-16.

C) When computing posting load and overload color code ratings for bridges constructed in 1985 or earlier, the live load shall be assumed to occupy the center of a single driving lane without concurrent live loading in any other lane. See Sections, 1-15 and 1-16.

D) When bridge geometric constraints (i.e., span length and girder spacing) are outside the range of live load distribution formulas specified in the AASHTO Specifications, the LDFAC program may be used to calculate the live load (single or multi-lane) distribution factors.

E) For use of live load distribution factor per LRFD Specifications, See Section 1-15.

F) The truck positions shown on Figure 1-4 shall be used to determine distribution factors for exterior stringers, exterior deck girders, through girders, and trusses.

When the roadway width, curb-to-curb, is greater than 18 feet but less than 24 feet, 2 lanes shall be placed on the structure as shown on Figure 1-4.

For roadway widths greater than 18 feet but less than 20 feet, each truck (or vehicle) shall be centered within the respective driving lane.

For roadway width 20 feet and greater, place one truck 2’-0” from one curb and the remaining truck 2’-0” from centerline roadway in the adjacent lane.

Truck Positions

Truck positions used to determine the Live Load Distribution Factors for select structures.

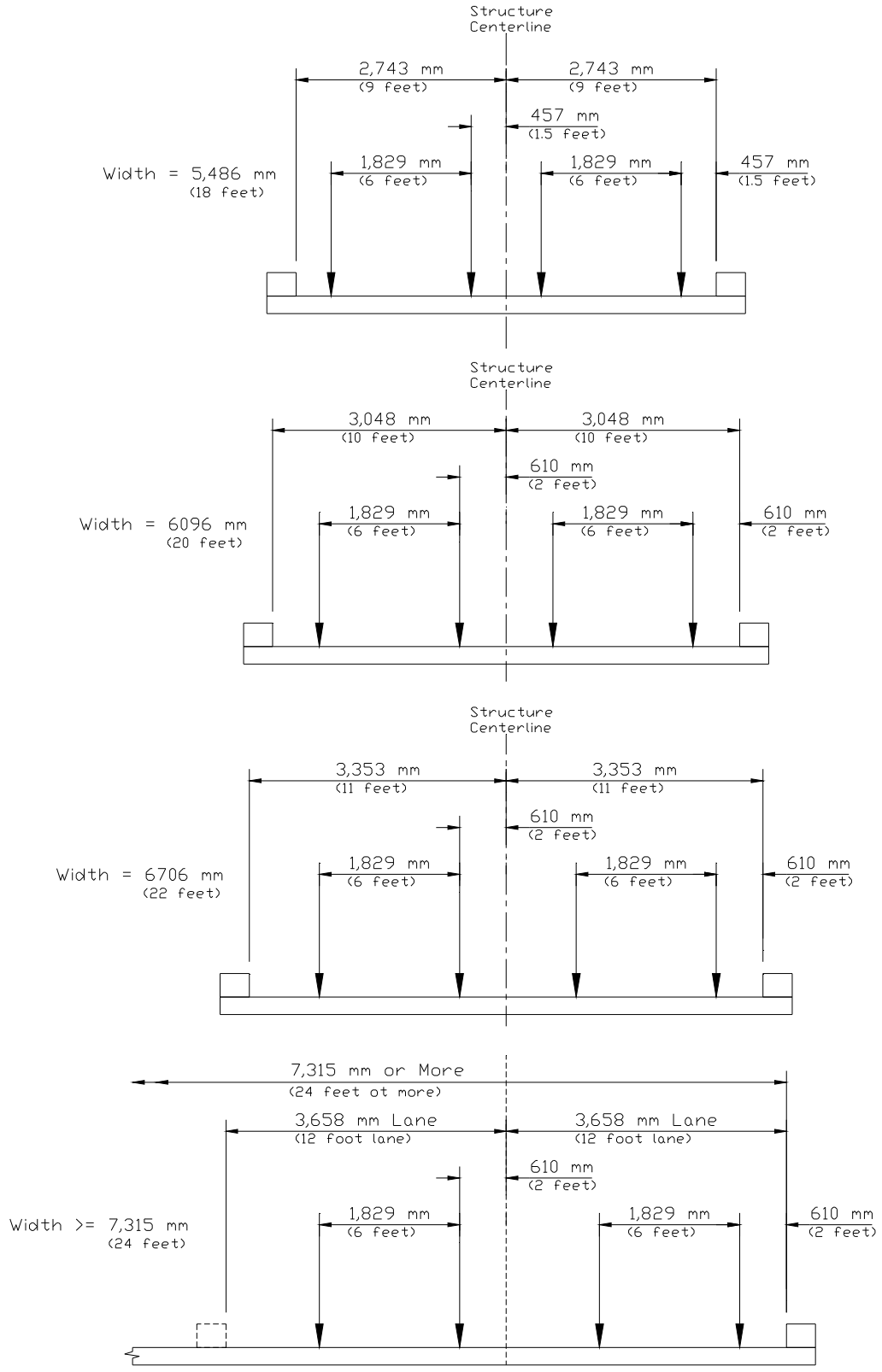


Figure 1-4

1-4 STRUCTURAL ANALYSIS METHOD USED TO DETERMINE BRIDGE RATINGS

All bridges designed after October 1, 2010 are to be rated with LRFR.

All LRFD bridges rated or rerated after October 1, 2010 are to be rated with LRFR.

All ASD & LFD bridges rated or rerated after January 1, 1994 are to be rated with LFR, to the extent LFR is applicable to the structure type per the AASHTO specifications.

All ASD and LFD bridges on the NHS are to be rated with LFR, to the extent LFR is applicable to the structure type per the AASHTO specifications.

Timber Structures shall be rated in accordance with the AASHTO Allowable Stress Method.

1-5 MATERIAL PROPERTIES USED TO DETERMINE BRIDGE RATINGS

For all structures the material properties used for the rating shall be based on the material grade or design stresses, specified in the plans. When plans are not available or they do not specify material grade or design stresses, then the rater must use judgment to determine the appropriate material properties based on the information available. Normally, this decision is based on the year the bridge was constructed. Table 1-1 is provided to help the rater with this process. Table 1-2 is provided for information only.

Table 1-1 shows the material properties, based on year of construction, used by the Colorado Department of Transportation. This material property table is based on the predominant grade of materials used by the Colorado Department of Transportation during the years indicated.

Table 1-2 shows the material properties for rating as stipulated by the AASHTO Manual for Condition Evaluation of Bridges.

After making a thorough investigation into all possible sources of information concerning an existing structure, if the rater is still unable to determine the grade of material used, or year of construction, then a conservative estimate of the construction year should be made. The material property Table 1-1 can then be used for determining the material properties for the rating.

NOTE: For steel structures, it is possible that the year of construction and the year of member fabrication are not coincident; e.g., when salvaged members have been utilized. In this case, the year of fabrication shall be used in determining allowable stresses.

Year of Construction - Allowable Stress Table
for
CDOT BRIDGE RATING

When the Actual Grade of the Material is Unknown

Material	Year of Construction	Fy or F'c (psi)	Working Stress Ratings		
			Inventory (psi)	Operating (psi)	Posting (psi)
			0.55Fy	0.75Fy	0.75Fy
Structural Steel *Bending*	Prior to 1905	26,000	14,000	19,500	19,500
	1905 to 1936	30,000	16,000	22,500	22,500
	1937 to 1963	33,000	18,000	24,500	24,500
	After 1963	36,000	20,000	27,000	27,000
				0.45Fy	0.45Fy
Structural Steel *Web Shear*	Prior to 1905	26,000	8,500	11,500	11,500
	1905 to 1936	30,000	9,500	13,500	13,500
	1937 to 1963	33,000	11,000	15,000	15,000
	After 1963	36,000	12,000	16,000	16,000
Reinforcing Steel *Tension*	Prior to 1954	33,000	18,000	25,000	25,000
	1954 to 1971	40,000	20,000	28,000	28,000
	After 1971	60,000	24,000	36,000	36,000
Concrete *Bending*	Prior to 1959	2,500	1,000	1,500	1,500
	1959 to 1976	3,000	1,200	1,900	1,900
	1977 to 1981	4,000	1,600	2,200	2,200
	After 1981	4,500	1,800	2,450	2,450
Timber (Douglas Fir Select Structural)	All Dates				
	Bending (Fb)	--------	1,600	2,128	2,128
	Shear (Fv) *	--------	113	150	150
	Shear (Fv) **	--------	85	113	113

* Allowable shear stress value to use when there are NO splits or shear critical cracks
** Allowable shear stress value to use when there are splits or shear critical cracks

Prestressed Concrete	Based on the Actual Grade of Material Used

Prestressing Steel Strands	Based on the Actual Grade of Material Used

Year of Construction - Allowable Stress Table
from the
AASHTO Manual for Condition Evaluation of Bridges - 2nd Edition

When the Actual Grade of the Material is Unknown

Material	Year of Construction	Fy or f'c (psi)	Working Stress Ratings	
			Inventory (psi)	Operating (psi)
			0.55Fy	0.75Fy
Structural Steel *Bending*	Prior to 1905	26,000	14,000	19,500
	1905 to 1936	30,000	16,000	22,500
	1936 to 1963	33,000	18,000	24,500
	After 1963	36,000	20,000	27,000
				0.45Fy
Structural Steel *Web Shear*	Prior to 1905	26,000	8,500	11,500
	1905 to 1936	30,000	9,500	13,500
	1936 to 1963	33,000	11,000	15,000
	After 1963	36,000	12,000	16,000
Reinforcing Steel *Tension*	Prior to 1954	33,000	18,000	25,000
	After 1954	40,000	20,000	28,000
Concrete *Bending*	Prior to 1959	2,500	1,000	1,500
	After 1959	3,000	1,200	1,900
Timber	N/A	--------	Per the AASHTO Design Specifications	1.33 * Inv
Prestressed Concrete	N/A	--------	Per the AASHTO Design Specifications	Per the AASHTO Design Specifications

Table 1-2

1-6 AVAILABLE RATING COMPUTER PROGRAMS

In general, the CDOT will use AASHTOWare Virtis to perform bridge ratings. Structures rated with the Virtis program will be defined and analyzed as a system. Post-tensioned bridges will be exempted from this requirement. All of the instructions and examples in the CDOT Bridge Rating Manual use the strip method of analysis (see AASHTO LRFD 4.6.2) and the AASHTO LFD live load distribution factors. Until otherwise provided for by the CDOT Bridge Rating Manual, curved superstructures and bridges designed by a refined method of analysis (LRFD 4.6.3) shall be rated using Virtis and the strip method unless the Staff Bridge Branch Bridge Rating Program Manager approves an exception. Equivalent distribution factors for composite dead loads and live loads shall be used to obtain the appropriate rating for moment at the sections required by the CDOT Bridge Rating Manual (see AASHTO LRFD 4.6.3.1, modified here as may be required for composite dead loads).

Before finalizing the rating package for submittal, Virtis users shall verify with the Staff Bridge Rating Engineer that the most current version of the program is used in the analysis. This ensures proper maintenance of CDOT'S Virtis/Opis database for future use. Ratings submitted to the CDOT that are based on older versions will be rejected.

For consultants working on projects within CDOT'S right-of-way, Virtis/Opis can be purchased at a discounted rate from the AASHTO; however, a written certification is required and should be requested from the CDOT Staff Bridge Branch.

Below is a current list of computer rating programs available from the Staff Bridge Branch Program Library. Any questions regarding the programs, including program access, should be directed to the Staff Bridge Rating Engineer.

A) BARS-Bridge Analysis and Rating System: BARS has been replaced by Virtis and BARS should not be used for any new ratings or reratings. Bars can rate steel girders, truss members and non-prestressed concrete girders.

B) PLANK-Corrugated Steel Plank Rating: Rates asphalt filled, corrugated metal plank decks placed perpendicular to traffic.

C) SLAB-Concrete Slab Rating: Rates slabs continuous over three or more supports with reinforcing placed perpendicular to traffic. The slab must be supported by longitudinal girders, and cannot be prestressed.

D) VIRTIS: Except for post-tensioned bridges, this program can perform analysis and rating of all other common structure types (including trusses) that are being designed or currently in the Colorado Highway System. The bridge model data is entered using the GUI window. The data is then exported into the BRASS or other engine(s) as appropriate, which performs the required

1-6 AVAILABLE RATING COMPUTER PROGRAMS *(CONTINUED)*

analysis and provides the final analysis results. **Tolerance feature of VIRTIS/OPIS:** VIRTIS tolerance feature can be set using the 'Configuration Browser…' in the Bridge Explorer Window. The tolerance for VIRTIS and the data export to BRASS ensures that any two locations or two lengths along a girder line are the same. Failure to set the tolerance values will cause errors during the analysis. When a higher version of the program is installed, it is required to set VIRTIS tolerances on each user computer. In US Customary units, the following tolerance values are for use in CDOT Staff Bridge and Consultants involved in projects located in CDOT's jurisdiction:

Unit	Tolerance
Ft.	0.01
In.	0.25
MI.	0.01

When rating a structure in Virtis, the structure number provided by the Staff Bridge BMS Unit will be used for the Structure ID Number. The following naming convention shall be used to organize the explorer window in VIRTIS/OPIS. For a structure being designed in OPIS the user will add the prefix (8) to the structure number. Overload critical bridges used for routing will be assigned the prefix (Z). Only structures on the critical list should be assigned the prefix (Z). Overload bridges requiring analysis but not on the critical list should use (9) as the prefix. When a rating is in progress or when re-rating a structure, Virtis users will add a(7) as the prefix. Once a rating is completed and signed by the rater and checker, the structure should be linked to the Pontis database. VIRTIS will automatically remove any prefix during the linking process. Therefore any structure without a prefix is the final rated structure.

Examples:
F-17-BY A final rated structure
7F-17_BY A structure being re-rated or a new rating in progress.
8F-17-BY A Structure in OPIS and OPIS-Substructure Design
9F-17-BY A Structure not on the critical list used for overloads.
ZF-17-BY A Structure on the critical list used for overload routing.

E) LDFAC-Distribution of Wheel Loads: The LDFAC program may be used to obtain live load distribution factors for most common types of bridges. It is recommended for use when the span length and girder spacing is outside the range of live load distribution formulas as specified in the AASHTO Specifications. The five common bridge types that the LDFAC may be appropriate for use are: Slab on girder (includes concrete T-beam, concrete I-girder and steel I-girder), slab, box girder, spread box girder and the multi-box beam bridges. This program uses the grillage analogy to model the bridge superstructure. Both the single and multi span (continuous over piers) bridges can be modeled. The supports may be normal or skewed and the distribution factors are calculated for both the single and

1-6 AVAILABLE RATING COMPUTER PROGRAMS *(CONTINUED)*

multiple lane loadings. In addition to the HS20-44 loading, other special vehicles may be used.

F) WIN DESCUS I-Design and Analysis of Curved I-Girder Bridge System: This program performs the complete rating of horizontally curved steel plate girder sections that act compositely or non-compositely with a concrete decking. The program can accommodate the WSD or the LFD method in the analysis. Simple span and continuous span bridges can be modeled. In addition to the AASHTO vehicles, the program allows the use of nine (9) user defined vehicles in the analysis. Program limitations: 1) Maximum number of spans = 11; 2) Maximum number of girders = 13; and 3) Maximum number of supports = 12. The program models the entire bridge as a 2-dimensional grid system using the stiffness method.

G) WIN DESCUS II-Design of curved box girder bridge system: This program performs the complete rating of horizontally curved steel sections (simply supported or continuous over piers) that act compositely or non-compositely with a concrete decking. In addition to the AASHTO vehicles, the program allows the use of one (1) user defined vehicle per analysis. The program models the entire bridge structure as a 2-dimensional grid system using the stiffness method. Program limitations: 1) Maximum number of spans = 8; 2) Maximum number of box girders = 9; and 3) Maximum number of supports = 9.

H) BDS CALFRAME - Frame Analysis: Used to analyze rigid frames and post-tensioned concrete structures. It does not perform a rating analysis, but produces the output information that can be used to complete the rating.

1-11 SUMMARY OF RATING PROCEDURE (IN-HOUSE)

I. Purpose

The purpose of the rating process is twofold. First, it determines and documents the maximum safe inventory and operating live load capacities of bridges. Second, the rating process can help find possible miscalculations or omissions in new superstructure designs. The design can then be corrected and the plans revised before the structure is built.

II. Responsibility

Work associated with the rating of bridges will be shared among the Bridge Design units. Each design unit shall service their assigned Region or Regions. The LOAD FACTOR RATING SUMMARY FORM (Green Color) is preferred for LFD rating and the TIMBER RATING SUMMARY FORM (yellow Color) is preferred for Timber rating (Refer to section 1-13). The Rater is the person selected to compute the ratings of a bridge. The Rater and the checker shall sign the

II. Responsibility *(Continued)*

"Rating Summary Form". The Rater is responsible for gathering all of the required materials, making all of the necessary calculations, and completing the rating package as outlined in Subsection 1-13. The Rater must also ensure that the most up-to-date Rating Summary Sheet, computer program manuals, and any other materials required to perform bridge ratings are available.

The Checker is the person responsible for verifying that the rating is accurate, that it follows established procedures, and that the rating package is complete. If the Checker finds any inaccuracies or omissions, the Checker will return the rating package to the Rater for corrections.

III. Procedure

See Figure 1-5 for a flow chart of the following:

Rating

The Rater makes the necessary sketches and calculations to show how the structure was modeled, dead loads were derived, and how other computer input was defined. The rater shall indicate the source of the structural data. The only sources of information used for rating shall be Advanced Plans, Construction Plans, As-Constructed Plans, and Field Surveys. The ratings are then completed using the proper rating procedure for the type of structure being assessed.

For new and rehabilitated bridges, inventory rating values lower than 36 tons when using LFR and rating factors less than 1.0 when using LRFR should be investigated and whether or not a redesign is needed should be determined.

To finish the rating documentation and complete the rating package, the Rater shall do all of the following:

A) Completely fill in all of the required forms.

B) Initial and date the computer output.

C) When rating a new design, on a separate sheet of paper, document the construction status for BMS and state if the rating is for a new bridge or for the reconstruction of an existing bridge. This sheet is to be kept with the Rating Summary Sheet.

D) Bind the rating package together.
E) Forward the rating package to the Checker.

1-11 SUMMARY OF RATING PROCEDURE (IN-HOUSE) *(CONTINUED)*

III. Procedure *(Continued)*

Checking

The Checker shall verify all calculations and ratings, e.g., proper modeling of the structure, accurate calculations, and proper computer input. If the rating is not complete, it shall be returned to the Rater. The Checker shall sign and date all of the rating material once the rating is accepted as complete and accurate.

Final Step

When the rating and checking is completed, the rating package shall be forwarded to the BMS (Bridge Management System) Unit. The assigned BMS unit personnel will then update the NBI. This Unit will review the package and if the documentation is incomplete at this step, the package will be returned to the Rater. The BMS Unit will not check the accuracy of the ratings.

All Virtis users (i.e., rating a new structure or re-rating an existing structure), when rating and checking is completed, the Rater shall notify the Bridge Rating Coordinator via e-mail that the structure is ready to be archived.

For a description of what shall be included in the rating package, see Subsection 1-13.

Posting loads and color code recommendations shall be submitted by the BMS Engineer to the Staff Bridge Engineer for approval, and then transmitted to the Region RTD, Region Maintenance Superintendent and Permit Office.

IV. Rating Program Manager

The Staff Bridge Rating Program Manager is responsible for the following: Rating Structure Data archives for all structures; provide assistance to in-house staff and consultants on bridge rating issues; update the CDOT Rating Manual; Opis/Virtis migration coordinator; coordinator for bridge rating software needs; and liaison with the Information System Engineering Customer Support Unit (ECSU) on rating related matters.

Rating Procedure (In-House)
For
New Bridges
Existing Bridges
Reconstructed Bridges

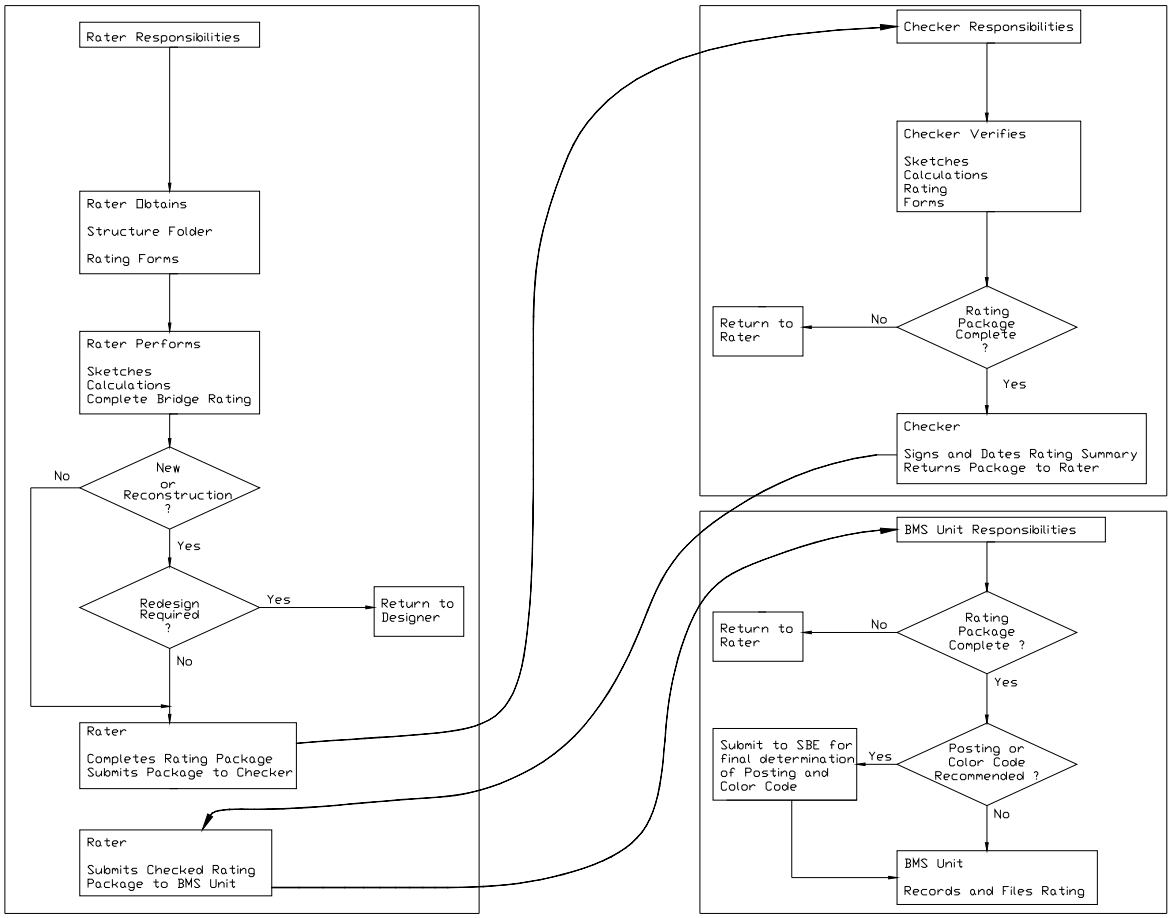


Figure 1-5

Rating Procedure (Consultants)
For
New Bridges
Existing Bridges
Reconstructed Bridges

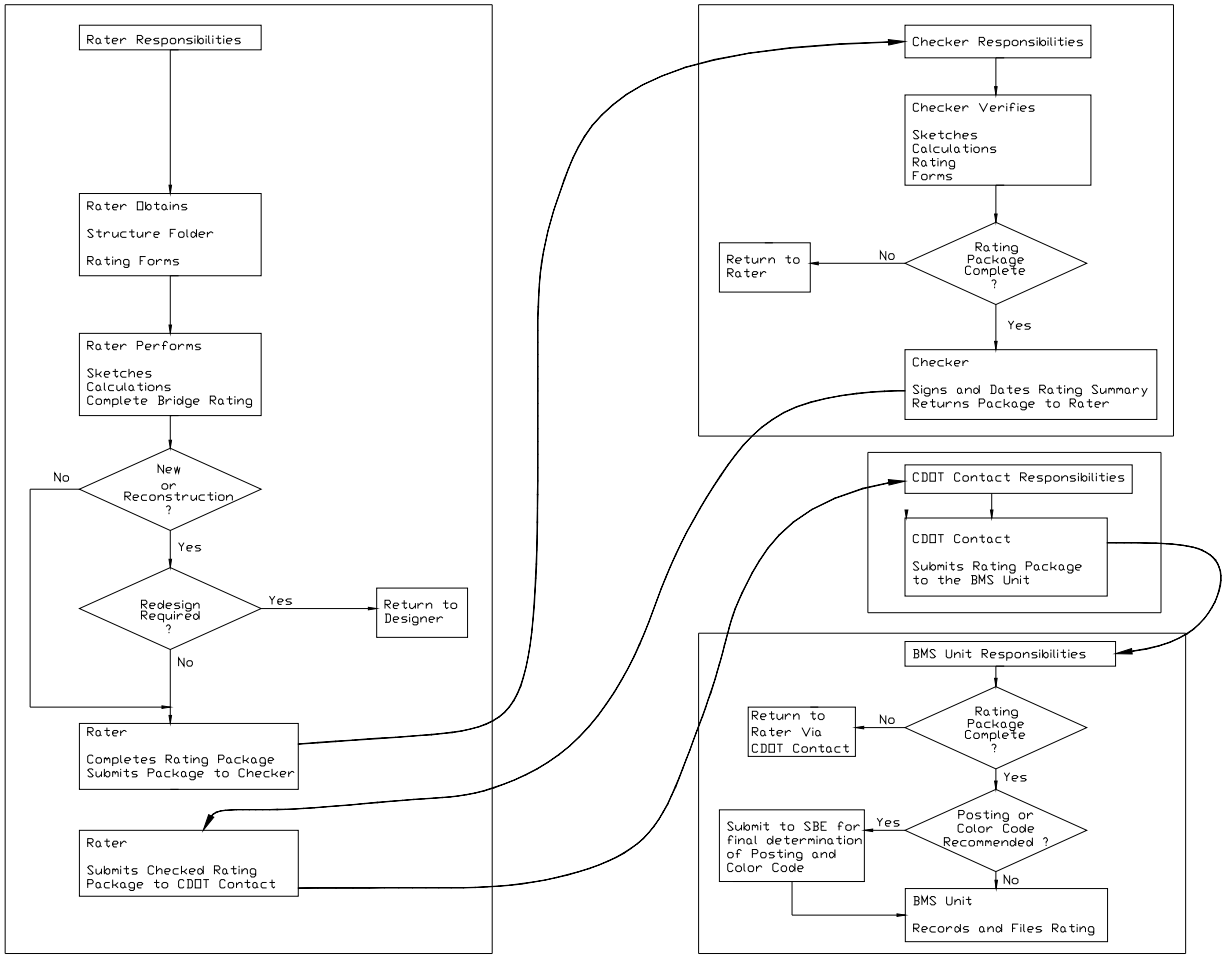


Figure 1-6

1-12 SUMMARY OF RATING PROCEDURE (CONSULTANTS)

The rating procedure for consultants is similar to the procedure described for Staff Bridge Design's "In-House" ratings. The differences arise in preparing for rating, defining responsibilities, and in directing lines of communications. Nonetheless, a complete description of the process, with defined responsibilities and definitions follows.

See Figure 1-6 for a flow chart of the following:

Rating

For ratings performed by Consultants, the term Rater, as used in this subsection, relates to an individual who is an agent of the hired consultant. This person will be responsible for structure ratings and will be the contact person with the Colorado Department of Transportation Staff Bridge Design. The Staff Bridge Design contact person for the Rater will be arranged at the outset of the contract. Any rating questions or requests should be communicated between the consultant's rater and the identified Staff Bridge Design contact.

The Rater will be responsible for gathering all the required materials, performing all the necessary calculations, and completing the rating package as stipulated in Subsection 1-13.

The Rater must have the most up-to-date computer program manuals, Rating Summary Sheets, and any other materials required to perform bridge ratings. The Rater can do this by simply checking with his Staff Bridge Design contact.

The formal rating analysis now begins. The Rater shall make the necessary calculations and sketches to show how the structure was modeled, how dead loads were derived, and to identify any other pertinent information. The rater shall indicate the source of the structural data. The only sources of information used for rating shall be, Advance Plans, Construction Plans, As-Constructed Plans, and Field Surveys. At no time shall design notes be used to rate a structure.

After this information is compiled, the Rater shall then use the appropriate analysis and computer programs to determine the structural capacity of the bridge. Refer to the section in this manual covering the appropriate structural type for a description of the computer programs and analysis to be used.

If the rating is for an existing bridge, completely constructed and in service, then all the rating documents shall be completed, signed, and dated by the Rater, and then forwarded to the Checker.

1-12 SUMMARY OF RATING PROCEDURE (CONSULTANTS) *(CONTINUED)*

Rating *(Continued)*

If the rating is for a new design, the Rater shall check to see that the new design is adequate. If the inventory rating value is less than 36 tons when rating in LFR or the rating factor is less than 1.0 when using LRFR, the cause should be identified and the structure designer contacted for a possible redesign. Otherwise, all the rating material shall be completed, signed, and dated by the Rater and forwarded to the Checker.

The Consulting firm's name shall also appear on the following documents: Rating summary sheet, rating calculations sheets and sketches.

Checking

The term Checker, as used in this subsection, refers to a person who is an agent of the hired consultant. The Checker has the responsibility for verifying that the rating calculations, structure modeling, and computer inputs are proper and accurate. If the Checker finds any errors, or omissions, the Checker shall return the rating to the Rater for corrections. Once the rating is complete, the Checker shall sign and date all rating materials before forwarding them for final step.

Final Step

The rating package shall be submitted by the Consultant to the appropriate Staff Bridge Design contact. This ensures that the contact is aware of the rating submittal.

The package of materials received by the Staff Bridge Design contact will then be transmitted to the BMS Unit for recording. BMS DOES NOT verify the accuracy's of bridge ratings. If the information is not complete at this step, the rating will be returned to Staff Bridge Design's contact for completion. The contact will have the Rater complete the rating documentation before returning it to the BMS Unit. The completed rating package will be recorded and filed by the BMS Unit and forwarded to the Bridge Rating Engineer for structure data archives. For a description of what shall be included in the rating package, see Subsection 1-13.

If the rating is for an off-system bridge, a duplicate submittal of the rating package shall be delivered to the applicable entity if requested or required by the entity.

1-13 RATING PACKAGE REQUIREMENTS

The following defines what the minimum requirements are for a complete rating package submittal. The rating examples contained in this manual further illustrate what is described below.

A) A completed Rating Summary Sheet, refer to Section 1-14 of this manual for a description on how this sheet shall be filled out. The summary sheet should be printed on colored paper to designate the analysis method used.
   a. Yellow paper shall designate use of the AASHTO ASD method.
   b. Green paper shall designate use of the AASHTO LFD method.
   c. Blue paper shall designate use of the AASHTO LRFR method.

B) A set of calculations sheets showing the derivation of dead loads, live load distribution factors, how the structure was modeled, computer input information, and other relevant considerations. Where applicable, the calculation sheets should show how any deterioration or damage was modeled. Indicate from what source the information was gathered. The only sources of rating information shall be, Advance Plans, Construction Plans, As-constructed Plans, and Field Surveys. Design notes are not acceptable. One copy of pertinent plan sheets used during the rating process, preferably 11”x17” size or 8.5”x11” size, shall be included with the rating package (includes new structures and existing structures rerated for designed changes).

C) Virtis users shall use the tabular report format to generate the output report to be included in the rating package. For users of other computer programs, output from each of the programs used to rate a structure shall be included in the rating package.

D) To enable CDOT to regenerate an analysis of the structure in the future, all rating packages shall include rating input files in electronic format as follows:

   1) File names should be based on Structure Number [i.e. H-02-FK.DAT or H02FK.SLB or H02FK.bbd].

   2) File extensions should generally refer to the rating package used [i.e. *.SLB refers to SLAB Rating Program and *.bbd refers to VIRTIS Rating Program].

   3) A sheet or README file listing the input files submitted and describing the rating software used (including version number) shall accompany the submittal.

   4) The electronic file submittal can be made using any acceptable method (i.e., IBM-Compatible CD-ROM or USB storage device).

This is required for all bridges, regardless of what software is used for rating.

A) A rating for the bridge deck shall accompany each package.

1-13 RATING PACKAGE REQUIREMENTS *(CONTINUED)*

B) When the rating is for a new design, on a separate sheet of paper, state the status of construction for the project and state if the rating is for a new bridge or for the reconstruction of an existing bridge. This sheet is to be kept with the Rating Summary Sheet.

C) The Rater and Checker's signature, with the date signed, are required on the Rating Summary Sheet. For other items in the rating package (i.e., calculation sheets, first page of each set of computer output), the Rater and Checker's initial with date are required. In addition, the structure number is required to be shown on all items in the rating package.

D) All of the items that compose the rating package shall be placed in a folder that is clearly labeled with the structure number. Each structure rated shall have its own folder with a complete rating package. This requirement includes structures whose rating results or calculations duplicate those used for another structure.

1-14 REPORTING THE RESULTS OF RATING CALCULATIONS

The results of rating calculations are to be reported by the Rater on the Rating Summary Sheet, CDOT Form 1187a Timber Rating Summary or 1187a Load Factor Rating Summary. See Appendix A for copies of these forms and section 1-13 for more detail.

The Rating Summary Sheet is retained in the structure folder as a record of the adequacy of the structure. The following items are to be observed in filling out the sheet.

A) The sheet is to be filled out in black ink.

B) All lettering should be clearly legible.

C) Crossing out of incorrect data will not be permitted. If an error is made, fill out a new Rating Summary Sheet.

D) The sheet must be signed and dated by both the rater and checker. Do not initial the sheet. When rating is performed by a consultant, the name of the consulting firm shall also be shown.

Information to be shown by the Rater on the Rating Summary Sheet:

A) Record the structure number, state highway number, VIRTIS BID number, structure type and, when appropriate, the parallel structure number. In addition to entering the state highway number, if the structure is located on a divided highway and carries traffic in one direction only, indicate the direction of traffic (EB, SB, etc.). Indicate if the structure carries ramp traffic.

1-14 REPORTING THE RESULTS OF RATING CALCULATIONS *(CONTINUED)*

B) Within the Summary Sheet, record the Inventory and Operating ratings obtained for each element requiring an analysis. All ratings shall be reported to tenths of a ton.

1. Stringers or Girders

a) When an exterior girder is rated, both the interior and the exterior girder ratings should be shown. The columns of the Summary Sheet shall be marked to identify the interior and exterior girders.

b) For rolled steel beams, state the girder type and size.

c) When applicable, state if the girder is an original girder or a girder installed during structure widening.

Note: If a structure is widened with girders that are different from the original in either cross-section or material properties, both the original and the widened girders should be rated and the critical original and critical widened girder loads shown on the summary sheet.

2. Trusses

a) Record the critical member ratings in the appropriate columns of the Rating Summary Sheet.

b) Label the truss members shown in the report using standard truss notation. See Section 10A.

C) If a posting vehicle analysis is required, record the posting ratings in the chart portion of the summary sheet only. For State Highway bridges, the Staff Bridge Engineer will make the determination of actual posting load and the pictorial trucks will then be filled in. For bridges that are not on the state system, the appropriate entity officials will determine structure load postings for structures under their jurisdiction.

D) Indicate the amount of surfacing used in the rating calculations.

1-14 REPORTING THE RESULTS OF RATING CALCULATIONS *(CONTINUED)*

E) The Comments section of the Rating Summary Sheet should contain the following information when applicable.

1) State if the individual critical member rates considerably below the other structure members, and is not representative of the entire structure.

2) State any reductions in cross-section or allowable stresses used to rate the member and the reason for the reduction.

3) The recommended color code for on-system bridges. The Staff Bridge Engineer must approve any color code recommendations of black, orange, and yellow.

F) When rating timber members, the “Comments” section of the Rating Summary Sheet should contain the allowable stresses for moment and shear used to rate the structure. A statement should be made to indicate if the rating was controlled by moment or shear.

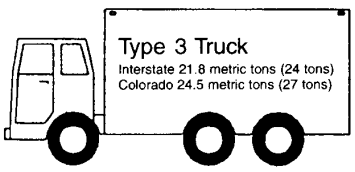
The Load Factor Rating Summary Sheet Depicted Below is Green.

COLORADO DEPARTMENT OF TRANSPORTATION

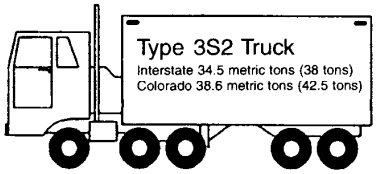
LOAD FACTOR RATING SUMMARY

Rated using Asphalt thickness: _____mm (_____in.) ❑ Colorado legal loads ❑ Interstate legal loads	Structure # State highway # Batch I.D. Structure type Parallel structure #

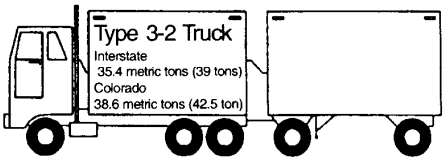
Structural member				
	Metric tons (Tons)			
Inventory	( )	( )	( )	( )
Operating	( )	( )	( )	( )
Type 3 truck	( )	( )	( )	( )
Type 3S2 truck	( )	( )	( )	( )
Type 3-2 truck	( )	( )	( )	( )
Permit truck	( )	( )	( )	( )



_____ (_____)
Metric tons Tons



_____ (_____)
Metric tons Tons



_____ (_____)
Metric tons Tons

Comments

Color Code:

Rated by	Date	Checked by	Date

Previous editions are obsolete and may not be used **CDOT Form #1187a 1/95**

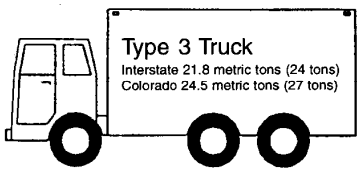
The Timber Rating Summary Sheet Depicted Below is Yellow.

COLORADO DEPARTMENT OF TRANSPORTATION

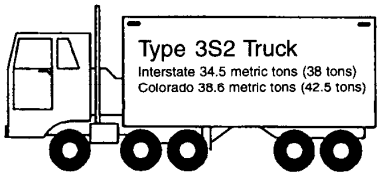
TIMBER RATING SUMMARY

Rated using Asphalt thickness: _____mm (_____in.) ☐ Colorado legal loads ☐ Interstate legal loads	Structure # State highway # Batch I.D. Structure type Parallel structure #

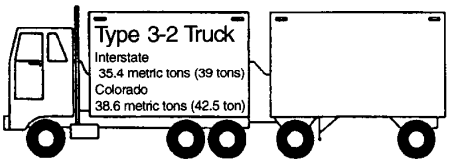
Structural member				
	Metric tons (Tons)			
Inventory	( )	( )	( )	( )
Operating	( )	( )	( )	( )
Type 3 truck	( )	( )	( )	( )
Type 3S2 truck	( )	( )	( )	( )
Type 3-2 truck	( )	( )	( )	( )
Permit truck	( )	( )	( )	( )



_____(_____)
Metric tons Tons



_____(_____)
Metric tons Tons



_____(_____)
Metric tons Tons

Comments

Repaired Stringer:
Allowable bending stress = psi
Allowable shear stress = psi
Color Code:

Split Stringer:
Allowable bending stress = psi
Allowable shear stress = psi
Color Code:

Rated by	Date	Checked by	Date

Previous editions are obsolete and may not be used **CDOT Form #1187a 1/95**

1-15 POSTING VEHICLE RATINGS

Posting Vehicle ratings, with the Overload Color Code ratings, are used to determine the maximum vehicle loads that will be allowed to travel on bridges. The Posting Vehicles are composed of the maximum vehicle loads currently permitted by law. Consequently, the Posting Ratings are a means for insuring the safe use of bridges by vehicles that do not exceed the legal loads.

If a structure rating indicates a need for posting, the Staff Bridge Engineer will be notified for approval and generation of a formal letter to the Permit Office, Region RTD and Region Maintenance Superintendent.

For the distribution of live load, see Section 1-3.

Whenever the operating rating value for a structural member is less than 36 tons, or the permit vehicle rating value is less than 96 tons, the LRFD live load distribution factor shall be used in the analysis and both the operating and the permit vehicle rating shall be recalculated. If the operating rating value is less than 36 tons when the LRFD distribution factor is used, the structural member shall be rated for the posting vehicles, and the results recorded on the Rating Summary Sheet. The inventory rating shall not be adjusted for the LRFD live load distribution factor.

Through past experience, the Colorado Department of Highways has found that when a member's operating rating is greater than or equal to 36 tons, its posting rating values are usually not less than the gross posting vehicle weights, or the difference is usually marginal. Therefore, when the operating rating is greater than or equal to 36 tons, the Colorado Department of Highways does not require posting rating to be calculated or recorded.

However, if the rater feels that a posting analysis would be helpful in assessing the overall condition of a structure whose operating rating is greater than or equal to 36 tons, then the posting rating values may be calculated and recorded on the Rating Summary Sheet.

When the posting ratings for bridge members are greater than or equal to 95% of the legal limits for the Colorado Posting Trucks (See Fig. 1-2; i.e., 0.95*27=25.6 Tons & 0.95*42.5=40.3 Tons) or the Interstate Posting Trucks (See Fig. 1-3; i.e., 0.95*24=22.8 Tons, 0.95*38=36.1 Tons & 0.95*39=37.0 Tons), the structure can be exempted from posting requirement. When the above conditions are satisfied, the Rater shall make that determination and fill out the Rating Summary Sheet accordingly.

The following is a summary on how to obtain posting ratings with the computer programs in the Staff Bridge Branch Program Library. The rater should consult each program's user manual for specific instructions.

A) BARS - Under normal operation, when the BARS computer program is used to obtain inventory and operating rating values, the posting rating values will be printed only when the operating rating is less than 36 tons. However, card type 01 may be modified in order to obtain the posting ratings regardless of the operating rating value.

1-15 POSTING VEHICLE RATINGS *(CONTINUED)*

B) PLANK – Posting rating values by AASHTO Working Stress are obtained only when the operating rating is less than 36 tons. However, the HS 20 wheel load will always control over the posting vehicle's wheel loads.

C) SLAB – Posting rating values are obtained only when the Operating Rating is less than 36 tons. However, the HS 20 wheel load will always control over the posting vehicles' wheel loads.

D) VIRTIS – When the proper live load analysis template (Created for CDOT Staff Bridge use; consists of different vehicles located in the VIRTIS library) is used or the required posting (Colorado or Interstate) vehicles are selected for the analysis, the program calculates the posting loads. Posting vehicle analysis may be performed whether the operating rating capacity is greater or less than 36 tons.

E) WIN DESCUS I – Posting ratings (9 non-standard vehicles) may be included in the analysis when the operating rating for the AASHTO vehicle is less than 36 tons.

F) WIN DESCUS II – Posting rating (1 non-standard vehicle per analysis run) may be included in the analysis when the operating rating for the AASHTO vehicle is less than 36 tons; therefore, three separate runs will be necessary.

G) NEGMOM – Posting rating values are obtained only when the moments due to the posting vehicles are listed on the program's input file.

H) PSG – Can’t perform posting ratings. Generally, posting ratings are not required for precast girders due to higher available operating capacity.

I) TIMBER – The posting vehicles are automatically analyzed with every run of the program. However, the posting rating values are printed only when the Operating Rating is less than 36 tons; or when two or more of the posting vehicles' rating values are less than the vehicles' gross weight; or when a combination of the above occurs.

1-16 OVERLOAD COLOR CODE RATING

An Overload Color Code is determined by rating the structure using the Colorado Permit Vehicle, see Figure 1-7. On existing simple span bridges where the previous color code was based on the Colorado Modified Tandem Vehicle, and the Permit Vehicle results in a more severe restriction, the Modified Tandem may be used to determine the color code. In this case the Staff Bridge Engineer will make the final determination on which rating to use.

When any bridge that was constructed after 1985 is rated or rerated it shall receive a Colorado Permit Vehicle operating rating for interior and exterior girders with full impact and multi-lanes loaded, as per Section 1-3.

When any bridge that was constructed before or during 1985 is rated or rerated it shall receive Colorado Permit Vehicle and Colorado Modified Tandem Vehicle operating rating with full impact and one lane loaded, as per Section 1-3.

The deck and the exterior girder ratings are generally not used in the determination of Color Code.

Overload Color Code rating is not applicable to off-system structures.

Tables 1-3 and 1-4 show the basic relationships between the Overload Color Code, the Posting Vehicle and the Legal Loads for the SI-Metric Units and Customary US Units respectively. Also, Graphs 1-1 and 1-2 show the color code and operating rating relationships graphically.

Color Code Table **SI - Metric Units**

	Units	White	Yellow	Orange	Black
Permit Vehicle	Tons SI	87.1 ≤ X	87.1 > X ≥ 80.3	80.3 > X ≥ 73	73 > X
Modified Tandem Vehicle	Tons SI	45.4 ≤ Y	45.4 > Y ≥ 41.7	41.7 > Y ≥ 38.1	38.1 > Y

X = Operating Rating Value

Y = Operating Rating Value

Posting Load Table

	Units	Colorado Roads	Interstate Roads
Type 3 Vehicle	Tons SI	24.5	21.8
Type 3S2 Vehicle	Tons SI	38.6	34.5
Type 3-2 Vehicle	Tons SI	38.6	35.4

Legal Load Table

	Units	Colorado Roads	Interstate Roads
Single Axle	Kilograms	9,072	9,072
Tandem Axle Group	Kilograms	18,144	16,329

Table 1-3

Color Code Table **Customary U.S. Units**

	Units	White	Yellow	Orange	Black
Permit Vehicle	(tons)	96 ≤ X	96> X ≥ 88.5	88.5> X ≥ 80.5	80.5> X
Modified Tandem Vehicle	(tons)	50 ≤ Y	50> Y ≥ 46	46> X ≥ 42	42> Y

X = Operating Rating Value

Y = Operating Rating Value

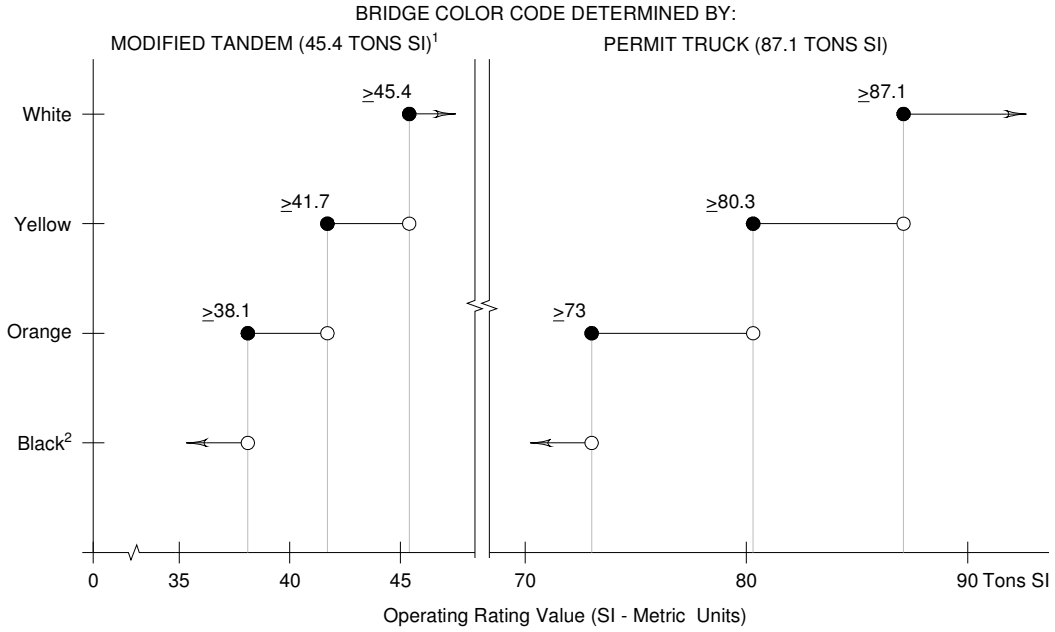
Posting Load Table

	Units	Colorado Roads	Interstate Roads
Type 3 Vehicle	(tons)	27.0	24.0
Type 3S2 Vehicle	(tons)	42.5	38.0
Type 3-2Vehicle	(tons)	42.5	39.0

Legal Load Table

	Units	Colorado Roads	Interstate Roads
Single Axle	(kips)	20.0	20.0
Tandem Axle Group	(kips)	40.0	36.0

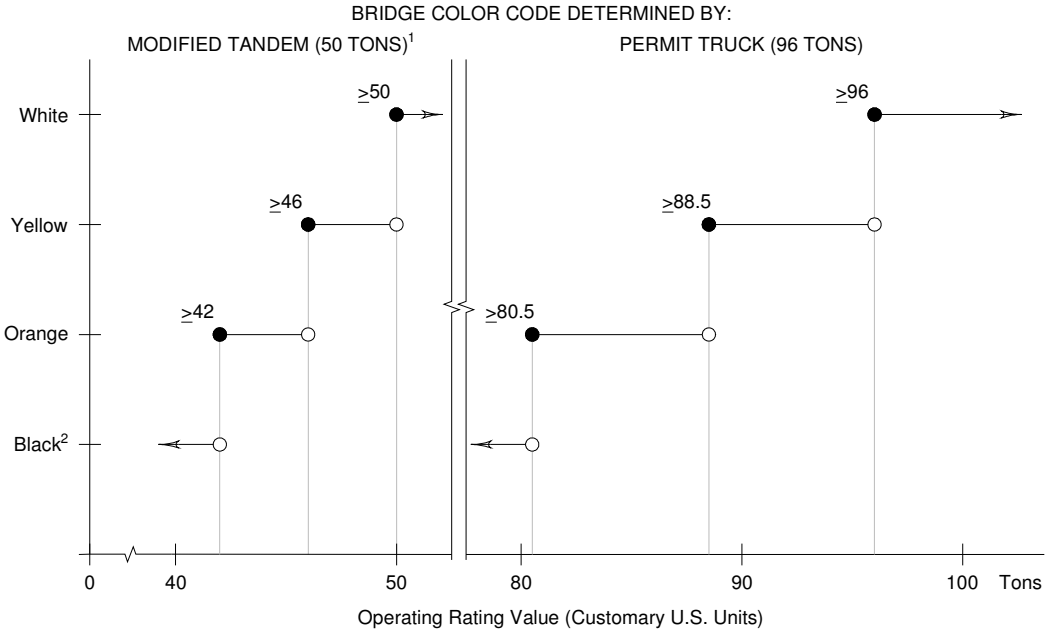
Table 1-4



[1] See Subsection 1-16, Overload Color Code Rating when the modified tandem determines the color code.

[2] A Bridge with a "Black" color code may also require load posting. See Subsection 1-15, Posting Vehicle Ratings for guidance when load posting should be investigated.

Graph 1-1



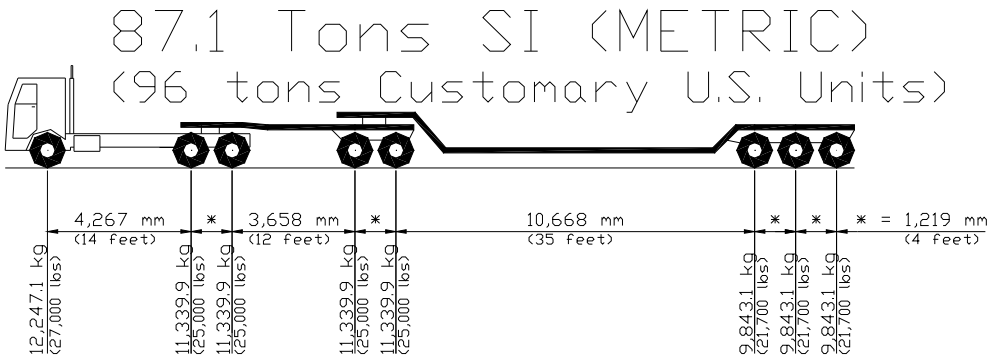
[1] See Subsection 1-16, Overload Color Code Rating when the modified tandem determines the color code.

[2] A Bridge with a "Black" color code may also require load posting. See Subsection 1-15, Posting Vehicle Ratings for guidance when load posting should be investigated.

Graph 1-2

Colorado Permit Vehicle

Vehicle used to determine the Overload Color Codes for all structures except for simple span structures.



Colorado Modified Tandem Vehicle

Vehicle used to determine the Overload Color Code for simple span structures.

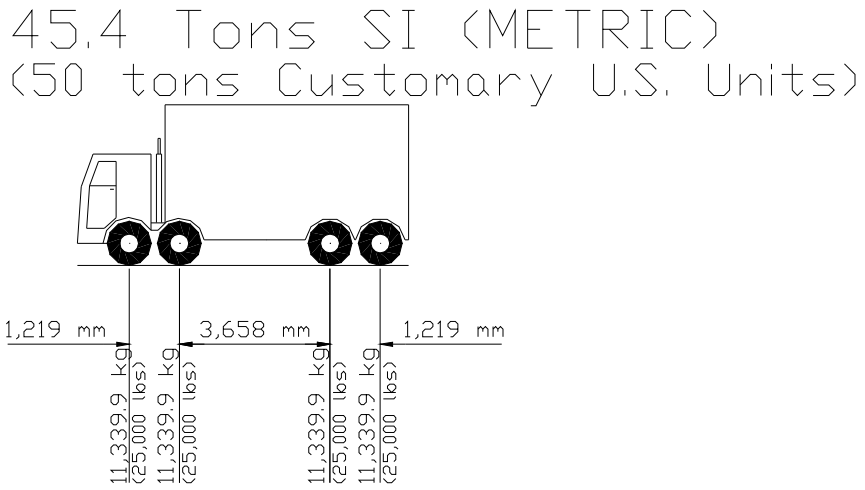


Figure 1-7

1-17 RERATING EXISTING BRIDGES FOR DESIGNED CHANGES

Whenever an existing bridge is modified by designed changes, it shall be rerated. Examples of designed changes are widening, reconstruction, deck rehabilitation, and repairs. The same procedures outlined for rating new bridges shall be followed, except where amended by this section.

The policies and guidelines for rating will be the same as those in the section of this manual covering the applicable structure type.

This section only covers the exceptions to the normal rating procedure that are necessary for rerating existing bridges modified by designed changes.

I. General

A) A rater who performs a rerate is responsible for all the data used in the same manner that would be necessary if it was a new rating.

II. Structure Number Assignment

A) For existing bridges that are being modified by designed changes, the rater should continue to use the Structure Number originally assigned to the structure for all rating related work.

B) When two parallel structures are modified and connected by a median closure project, the BMS Unit will combine the structure information into one structure number and folder. For in-house ratings, the rater shall coordinate the selection of the structure number with the BMS Unit. For Consultants, the rater should coordinate the selection with the Staff Bridge Design contact.

III. Members Requiring Rating

A) When structures are widened, any one of the following girders may produce the critical rating. The following list should be considered as the minimum number of girders to be investigated for any structure.

1. Critical interior girder of original structure.

2. Exterior girder of original structure that becomes an interior girder after construction is completed.

3. Critical interior girder of widened portion.

4. The exterior girder of the widened portion.

1-17 RERATING EXISTING BRIDGES FOR DESIGNED CHANGES *(CONTINUED)*

B) For bridges with proposed widening, a rating is required for each widened portion of bridge deck, as necessary. The critical rating for widened portions of deck should be reported along with the rating of the original deck.

IV. Reporting Ratings

A) The rater shall prepare a simple sketch showing the cross-section of the new structure with essential information used by the rater in the rating calculations.

B) The rater and checker shall complete and document the rating as described in this section and other sections applicable to the structure type.

C) For bridges on the state highway system, the rater shall add a separate sheet of paper to the rating package. This sheet shall be kept with the rating summary sheet and shall contain the following information:

1. A description of why the structure was rerated.

2. The status of construction for the designed changes.

3. Notification that the previous rating summary sheet contains the official rating values until construction is complete.

4. The structure number.

5. The Rater's signature, or initials, with the date signed.

D) Do not cross out the previous rating summary sheet if construction for the designed modifications has not been completed.

1-18 RERATING EXISTING BRIDGES FOR FIELD CHANGES

Whenever an existing bridge is modified by field changes, it shall be evaluated to determine if a new rating is necessary. Some examples of field changes are collision, additional layers of surfacing (i.e., when the change in asphalt or concrete resurfacing thickness is equal to and greater than 3"; See Section 1-1), and deterioration of bridge members. When a new rating is necessary, the procedures outlined for new ratings shall be followed, except where amended by this section.

The policies and guidelines for rating will be the same as those in the section of this manual covering the applicable structure type.

This section only covers the exceptions to the normal rating procedure that are necessary for rerating existing bridges modified by field changes.

I. General

A) Reratings requested by the Inspection Program Manager due to field changes shall be completed within 90 days after the Rating Program Manager receives notice. Working with the Rating Program Manager, the Inspection Program Manager may establish a shorter or longer timeframe as warranted by the field conditions. A timeframe other than 90 days shall be established in writing.

B) When rerating a structure, the rater shall review the previous inspection reports and rating information found in the structure folder. This is to verify the information used for rerating is both accurate and up-to-date. In particular, the rater shall look for inspection reports that document stringer condition and rater shall adjust the rating information accordingly.

C) When confronted with conflicting information, use the values that produce the lowest rating. Do not rate the average condition of the structure, but rate for the critical condition.

D) The rater should never increase member sizes or stresses from a previous rating unless rater can substantiate the upgraded condition. It is conservative, however, to decrease or downgrade the rating values with less justification.

E) A rater who performs a rerate is responsible for all the data used in the analysis.

1-18 RERATING EXISTING BRIDGES FOR FIELD CHANGES *(CONTINUED)*

II. Reporting Ratings

A) The rater and checker shall complete and document the rating as described in Section 1-14 and other sections applicable to the structure type.

B) The rater shall modify the previous rating summary sheet filed in the structure folder as follows:

1. Mark through (cross out) the previous rating summary sheet filed in the structure folder.

2. In the comments section of the sheet, add a brief comment as to why the structure was rerated. The rater is to initial and date these comments.

3. The previous rating summary sheet is to remain in the structure folder.